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ABSTRACT

Price indices related to specific expenditure categories are necessary for realistic budget projections in higher education. Given the erratic inflationary behavior of the past seven years, and the uniqueness of higher education expenditures, realistic inflation prediction requires a balanced combination of analytic forecasting and intuitive projection. Methodology developed for inflation prediction at the University of Massachusetts/Amherst prepares price indices tailored to the University budget. Forecasts are based on analysis of inflation trends since 1971, and allow for subjective weighting of trends by a budget analyst. The data base used for analytic forecasting is a set of quarterly price indices selected from readily available sources. University price indices are derived that correspond to specific expenditure categories. Long-term, medium-term, and short-term inflation predictors are analytically developed. The budget analyst supplies subjective weighting to the three inflation predictors to obtain an overall inflation predictor for each expenditure category. The paper includes a description of the analytic methodology and discussion of implementation in the budget planning process. (Author)

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BUDGET PREPARATION

AND

INFLATION PREDICTION

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BUDGET PREPARATION AND INFLATION PREDICTION

ABSTRACT

Price indices which are related to specific expenditure categories are necessary for realistic budget projections in higher education. Given the erratic inflationary behavior of the past seven years, and the uniqueness of higher education expenditures, realistic inflation prediction requires a balanced combination of analytic forecasting and intuitive projection. Methodology developed for inflation prediction at the University of Massachusetts/Amherst prepares price indices tailored to the University budget. Forecasts are based on analysis of inflation trends since 1971, and allow for subjective weighting of trends by a budget analyst. The data base used for analytic forecasting is a set of quarterly price indices selected from readily available sources. University price indices are derived which correspond to specific expenditure categories. Long term, medium term, and short term inflation predictors are analytically developed. The budget analyst supplies subjective weighting to the three inflation predictors to obtain an overall inflation predictor for each expenditure category. The paper includes description of the analytic methodology and discussion of implementation in the budget planning process.

BUDGET PREPARATION AND INFLATION PREDICTION

Introduction

Most state universities are faced with the annual or biennial task of preparing budget requests which accurately present the needs and requirements of the University system. These are prepared by the budget or financial office and are submitted to the Governor and the state legislature. The budget requests of necessity include adjustments for inflationary trends. Executive and legislative branches of the state government base their budget recommendations on the request submitted, the needs of other state agencies, and the current health of the economy.

One problem encountered by higher education institutions is the *reduced budget base* created by the nationwide retrenchment over the past five or six lean years. This has had the effect of placing the institution behind the purchasing power curve when using state mandated price indices and has led to under-financing in most cases. The problem can be highlighted by documenting the impact of past and projected inflation on the institution's operations. But inflation factors must be truly representative of the institution's expenditures if they are to show the true erosion of purchasing power.

State legislatures have a propensity for offering inflation factor percentage guidelines to *all* state agencies without regard for the uniqueness of their budget expense categories. An inflation factor selected for equipment, for example, may be applicable to major construction equipment purchases by the highway department, but it is hardly representative of the price increases for laboratory and scientific equipment used in higher education.

Price indices published by the government can describe expenditures but only if expenditures are broken down to over 1,000 categories. While the use of so much detail precisely describes inflation, it is of little use in budgeting. Kent Halstead (1977) has shown that the effects of inflation on budgets in higher education are quite different from inflationary effects in other areas of the United States economy. Although the Higher Education Price Index (HEPI), Halstead (1977), provides an excellent overview of inflation in higher education, HEPI does not provide the detail necessary to define specific price indices for each of the budget line items which need to be evaluated in preparing a budget request for a particular state university.

Universities are faced with a demanding situation: budget requests must be strongly justified at the state level, yet the influence of inflation on higher education expenditures is both unique and significant. What is required is a system that contains a manageable and uncluttered list of price indices which accurately reflect the purchasing needs and habits of the institution. The system should provide flexibility for adjusting to the unique expenditures of a particular institution and allow subjective evaluation of inflation forecasts.

The inflation prediction model described below defines a historic price index and forecasts inflationary trends for each budget line item. The price indices and forecasts are based on specific price indices published by the United States Government and by accepted business sources. Through the use of these university specific but externally validated price indices, the budget analyst can: observe historic inflationary trends for different components of the university budget, compare inflation adjusted appropriation changes for various parts of the university budget, and -- as described below--obtain analytic forecasts of future

inflationary behaviors specifically tailored to university expenditure patterns.

While the model can be fairly easily adapted to any public university budget process, the examples used are drawn from the experience of implementing inflation prediction at the University of Massachusetts at Amherst. A brief description of the budget process and the budget system structure at the University of Massachusetts/Amherst is presented below.

The Budget System and the Budget Request Procedure

The University of Massachusetts and the Commonwealth of Massachusetts operate on a single fiscal year (July 1 to June 30) budget cycle. The budget requests from the President's Office and the three campuses of the University are separately contained in a single document. After approval by the President's Office and the Board of Trustees, copies of the formal request are submitted to the state executive and legislative branches approximately nine months before the start of the applicable fiscal year. Obviously, campus units begin preparation of their budget requests long before this. usually one to one-and-a-half years before the start of the fiscal year.

The format used in preparing the request allows for consideration of inflationary trends and program changes. An example of the format is shown in Table 1.

After deliberation, debate and decreases (the trend over several years), the budget is approved by the legislature and signed by the Governor. Hopefully, all this occurs before July 1, the start of the fiscal year.

The budget system in the Commonwealth is divided into sixteen *subsidiary* accounts (major line items...e.g., Personnel, Travel, Equipmental Rental, etc.) and appropriations are made by line item. The Governor does have line

item-veto powers but the University has been legislatively empowered with fiscal autonomy. This autonomy allows--with Trustee approval--each campus of the University to transfer funds between line items. Each of the sixteen subsidiary accounts is further subdivided into object codes, which are more specific expenditure items. The assignment of budget items to a particular object code and subsidiary account is a result of rational choice and historic accident. Although campus budgetary control is done at the *subsidiary* level, departmental requests are made by object code. Price indices are applied to these more specific expenditure categories. An example of one part of the University of Massachusetts/Amherst Budget System is provided in Figure 1.

Formulation of Price Indices

Price indices have been developed which represent the effects of inflation on each budget category (object code and subsidiary account) at the university. The external validity of these price indices is insured by basing them on published price indices.

Given: i = expenditure item

j = year

k = quarter within year

$p_{i,j,k}$ = published price index for expenditure item i, year j, quarter k

w_{ir} = weighting factors which reflect the relative amount of item i purchased through expenditures in object code r.

w_{is} = weighting factor reflecting relative amount of i purchased through expenditures in subsidiary account s.

M_r = set of expenditure items i included in object code r

M_s = set of expenditure items i included in subsidiary account s

Then:

$$\Phi_{rjk} = \sum_{i \in M_r} w_{is} \; p_{ijk}$$

where Φ_{rjk} is a constructed price index representing inflationary effects in object code r, during year j, quarter k.

Likewise:

$$\Phi_{sjk} = \sum_{i \in M_s} w_{is} \; p_{ijk}$$

is a constructed price index representing inflationary effects in subsidiary s, during year j and quarter k.

Φ_{rjk} and Φ_{sjk} provide a national picture of inflationary pressures effecting purchases in the rth and sth account. The assumptions underlying Φ_{rjk} are as follows:

1. Published price indices from the sources listed below accurately represent inflationary trends.
2. The price indices (p_{ijk}) represent the goods and services purchased by the university.
3. The assigned weighting factors (w_{is}, w_{ir}) are accurate reflections of quantities purchased.

Given these assumptions, the Φ_{rjk} price indices are a valid representation of inflationary trends on university expenditures. As such Φ_{rjk} can be used for analysis of budgets and expenditures in a variety of ways. For example, Φ_{rjk} can be used to:

1. Develop a university price index which reflects overall inflationary trends affecting university expenditures.

2. Compare inflation adjusted changes in expenditures by account. That is: are increases in budgets keeping ahead of inflationary pressure in some accounts but falling behind in others?

3. Forecast future inflationary trends. The model used to project inflationary trends is described in the next section.

The p_{ijk} are published indices selected to represent the items (i) purchased by the university. The p_{ijk} are obtained from:

-Wholesale Price and Price Indexes, Table 6

-Construction Review Monthly Industry Report - Table E/2

-Consumer Price Index - Table 2

-Survey of Current Business

-Higher Education Price Index - Table 8

Several examples of the price indices, p_{ijk}, and expenditure items i selected are displayed in Table 2. The complete list is available from the authors.

The weighting factors (w_{ir}, w_{is}) are determined through analysis of patterns of expenditure patterns since 1971. The weights (w_{ir}, w_{is}) represent relative quantity purchased of item i in budget category r or s. A schematic view of the formulation of $\Phi_{s,j,k}$ is shown in Figure 2.

Forecasting Inflationary Trends

Forecasts are needed to answer the question: How will inflation effect expenditures in each budget category? Three forecasts are prepared: the long term trend, the mid term trend of the past two years, and the short term trend of the most recent two quarters.

Long Term Trend Projection via Exponential Smoothing

Makridakis and Wheelwright (1978), Chambers, Mallick and Smith (1971)

Given: Φ_{rjk} = price index;

r = object code

j = fiscal year, 1971 to present

k = quarter of fiscal year

and n = number of years of price index data.

Then, the yearly price index for object code r equals:

$$Y_{rj} = 1/4 \sum_{k=1}^{4} \Phi_{rjk}$$

and the percent change from year j-1 to year j equals:

$$\Delta_{rj} = 100 \, (Y_{r,j} - Y_{r,j-1})/Y_{r,j-1}$$

The long term projected rate of inflation is defined as:

$$L_r = \left(\sum_{j=2}^{n} (\Delta_{rj}) \, (a) \, (1-a)^{n-j}\right) / \left(\sum_{j=2}^{n} a \, (1-a)^{n-j}\right)$$

Where the smoothing coefficient a, is set equal to .2 which allows a good following of trend without responding excessively to major variations.

Mid Term Trend Projection via Linear Extrapolation

Given Φ_{rjk} and calculating Y_{rj} as defined above, then the mid term inflation prediction is defined as:

$$M_r = 100 \, (Y_{r,n} - Y_{r,n-1})/Y_{r,\,n-1}$$

Short Term Trend Projection via Linear Extrapolation

Given $\Phi_{r,j,k}$ the short term inflation prediction is defined as:

$$S_r = (4) \, (100) \, (\Phi_{r,n,k} - \Phi_{r,n,k-1}) / \Phi_{r,n,k-1}$$

Figure 3 illustrates projections of mid term and short term inflationary trends.

The overall projected rate of inflation for budget category r is then set equal to a weighted sum of the three forecasts:

= (weight assigned to rth long term projection) L_r

+(weight assigned to rth mid term projection) M_r

+(weight assigned to rth short term projection) S_r

Although the three predictors (long, medium, short) can be weighted equally in forecasting future inflationary trends, in the more general case the budget analyst may decide that one predictor is more important

than another. For example, the short term predictor may predict a decreasing rate of inflation based on the last two quarters but the analyst may know that the recent drop in prices is a temporary phenomenon. In this case, the short term projection would be ignored in determining the projected rate of inflation by assigning a weight of zero to the short term projection.

Implementation at the University of Massachusetts at Amherst

A computer program, written in Fortran IV, processes the twenty eight quarters of price index data for each of the sixty-nine published price indices. An initial run calculates long term, mid term, and short term inflation predictions for the budget categories. The budget analyst can modify the relative importance of each projection and rerun the program to obtain the final set of inflation projections. This final set of projections is then used in preparing the budget request. A full listing of the program and the input files is available from the authors.

Summary

A model which forecasts future inflation rates for university expenditure categories has been developed. The forecasted inflation rate is a weighted average of the long term, mid term, and short term inflation prediction for the expenditure category. The forecast is based on university price indices which have been designed to correspond to the type of goods and services purchased by that particular university. The university price indices are derived directly from a larger set of price indices published by the United States Government and other commonly accepted sources. The use of published price indices provides a strong base for justifying the validity of the inflation adjustments used in budget planning.

References

Chambers, J., Mullick, S. and Smith, D. How to choose the right forecasting technique. Harvard Business Review, July - August, 1971.

Halstead, K. Higher Education Prices and Price Index. Washington U.S. Government Printing Office, 1974, 1975, 1976, 1977.

Makridakis, S. and Wheelwright, S. Interactive Forecasting. San Francisco: Holden - Day Inc., 1978.

FIGURE 1

EXAMPLE: STRUCTURE OF THE UNIVERSITY OF MASSACHUSETTS/AMHERST BUDGET SYSTEM

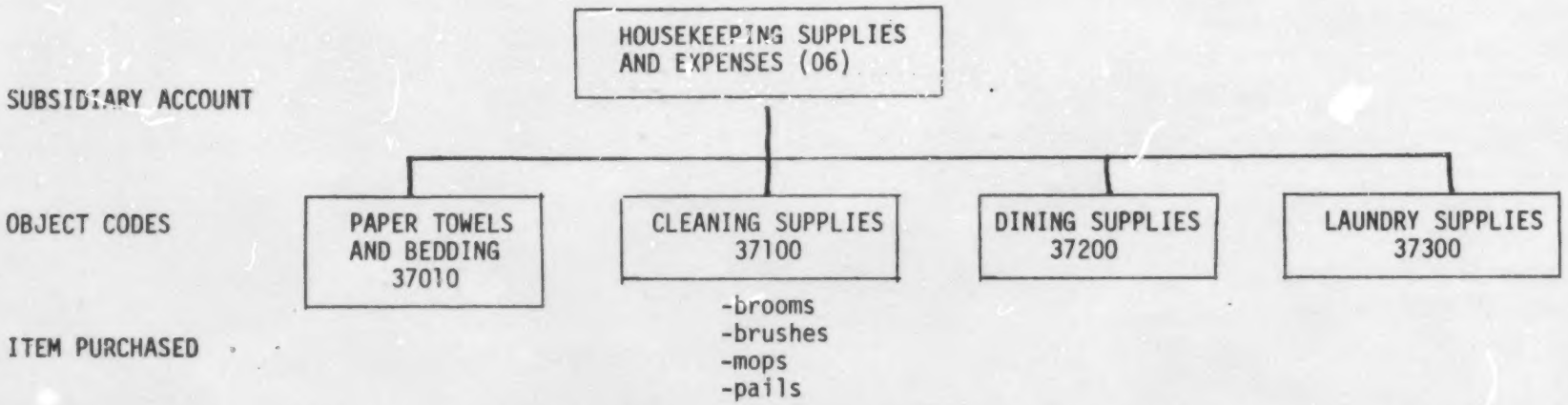

FIGURE 2

A SCHEMATIC VIEW: CALCULATING $\Phi_{s,j,k}$

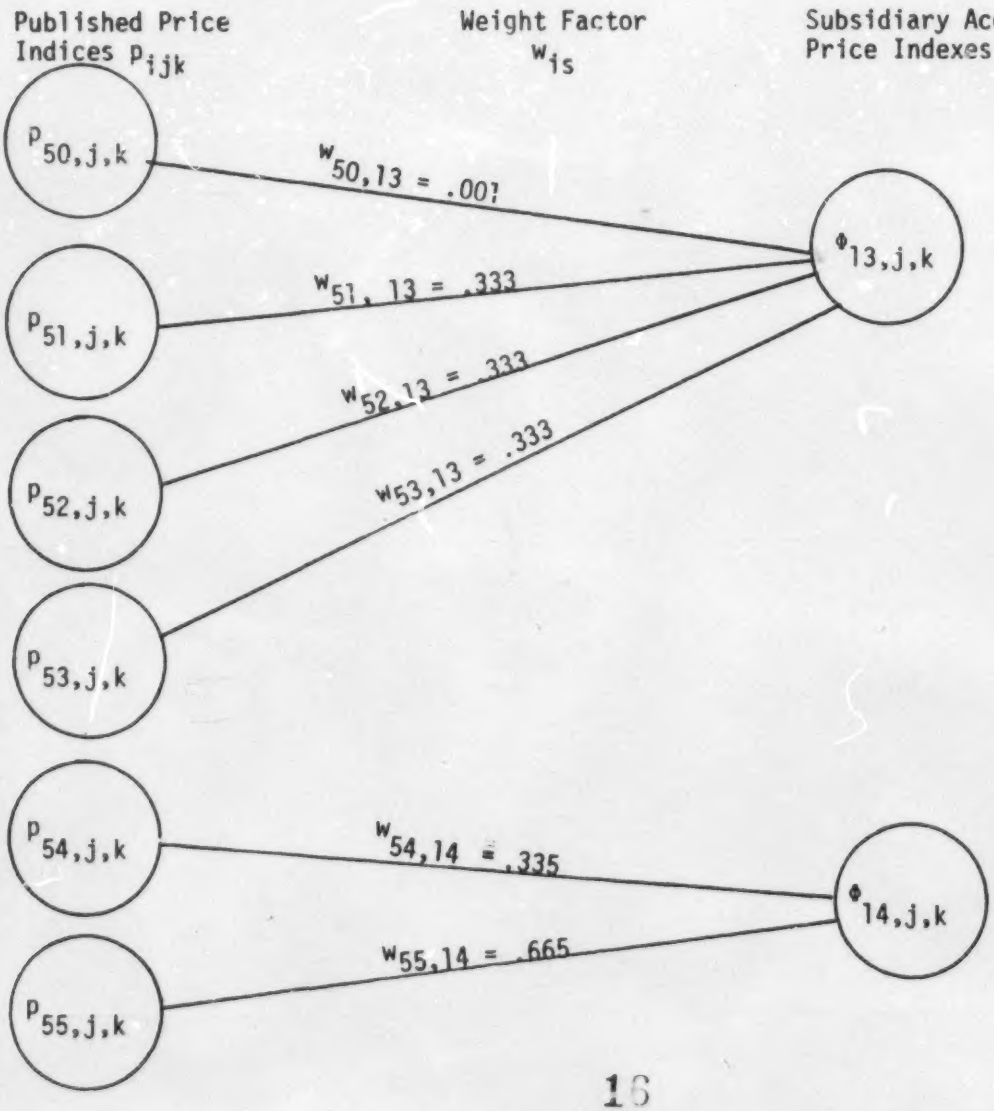

FIGURE 3

MID TERM AND SHORT TERM INFLATION PROJECTION

Example for Object Code 55010 Advertising

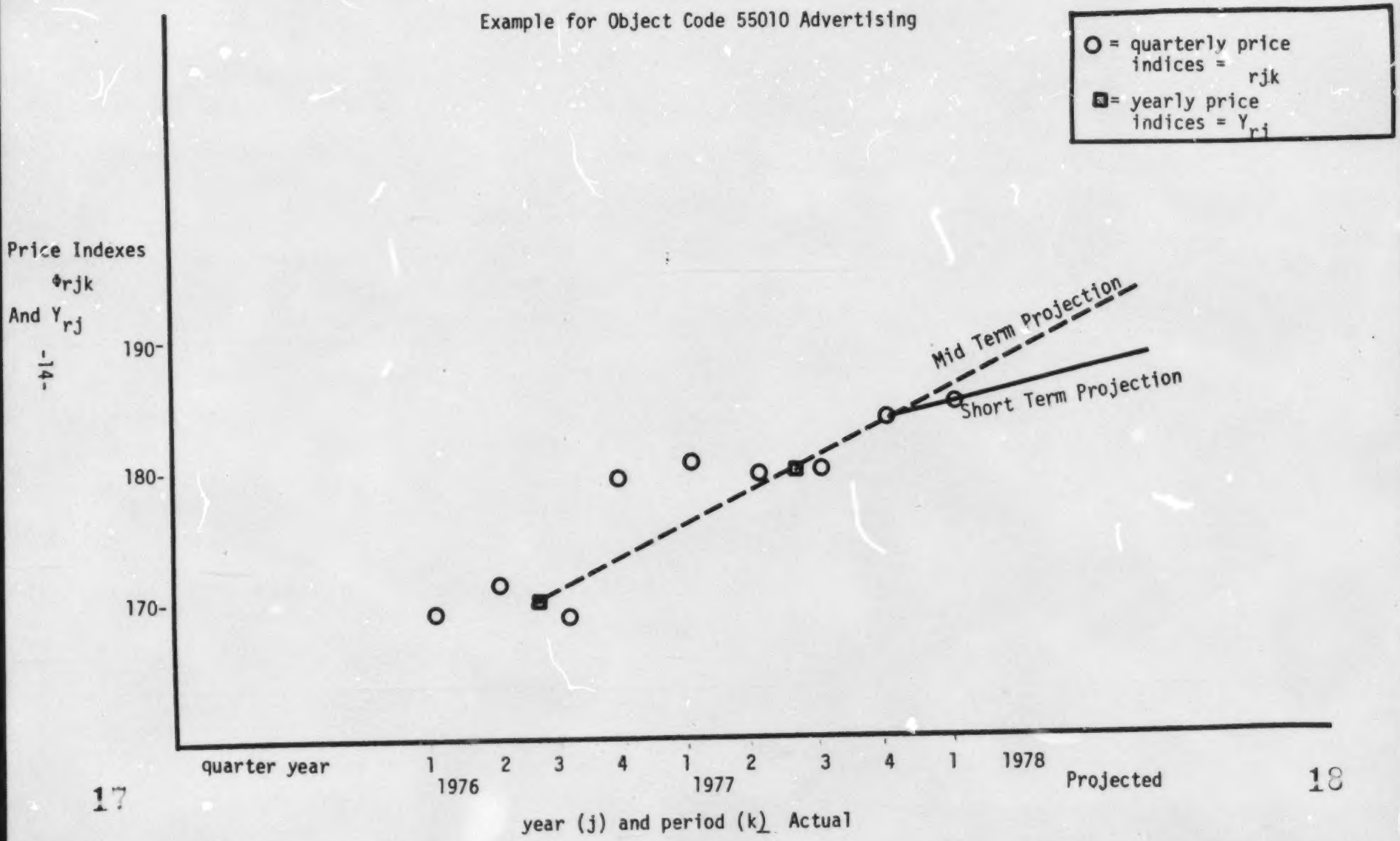

TABLE 1

3UDGET REQUEST FORMAT

UNIVERSITY OF MASSACHUSETTS AT AMHERST

OBJECT CODE	BUDGET BASE	PROJECTED RATE OF INFLATION	INCREASE DUE TO INFLATION	PROGRAM CHANGES	BUDGET REQUEST
37010	$ 10,000	8.5%	$ 850	$ -	$ 10,850
37100	200,000	7.5%	15,000	-	215,000
37200	20,000	8.6%	1,720	2,000	23,720
37300	50,000	8.6%	4,300	(3,000)	51,300
Subsidiary 6	280,000	7.8%	21,870	(1,000)	300,870

TABLE 2

SELECTED EXAMPLES: UNIVERSITY EXPENDITURE CATAGORIES

AND RELATED EXTERNAL PRICE INDICES (p_{ijk})

UNIVERSITY EXPENDITURE CATAGORIES			EXTERNAL PRICE INDICES	
OBJECT CODE	SUBSIDIARY ACCOUNT	DESCRIPTION	p_{ijk}	DESCRIPTION OF p_{ijk}
35000	5	Clothing including uniforms	WPI 0352/08	Textile products and apparel: Work Clothing
37010	6	Blankets, Linens Towels, & Bedding	WPI 037	Miscellaneous Textile Products
60800	12	Maintenance Repair Materials	CR	Composite of all construction material
			CR	Plywood, Group Index
			CR	Building Paper & Board
			CR	Prepared Paints
			CR	Builders Hardware
			CR	Copper Water Tubing
			CR	Plumbing Fixtures

WPI = Wholesale Prices and Price Indexes

CR = Construction Review